National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology

NASA SBIR Topic S2

Proximity Glare Suppression for Astronomical Coronagraphy (S2.01)
Precision Deployable Optical Structures and Metrology (S2.02)

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Overview

- High Contrast Imaging
  - State of the Art: coronagraphs and starshades
- S2.01 Subtopic Proximity Glare Suppression
- S2.02: Precision Deployable Optical Structures and Metrology
- Current Phase I and Phase II Proposals

S2.01 Proximity Glare Suppression

Lead Center: JPL, subtopics mgr Stuart Shaklan
Participating Center(s): ARC, GSFC

- This subtopic addresses the unique problem of imaging and spectroscopic characterization of faint astrophysical objects that are located within the obscuring glare of much brighter stellar sources.

Starlight Suppression Technologies

- Image plane hybrid metal/dielectric, and polarization apodization masks in linear and circular patterns.
- Transmissive holographic masks for diffraction control and PSF apodization.
- Sharp-edged, low-scatter pupil plane masks.
- Low-scatter, low-reflectivity, sharp, flexible edges for control of scatter in starshades.
- Systems to measure spatial optical density, phase inhomogeneity, scattering, spectral dispersion, thermal variations, and to otherwise estimate the accuracy of high-dynamic range apodizing masks.
- Methods to distinguish coherent and incoherent scatter in broad band speckle field.
- Coherent fiber bundles consisting of up to 10,000 fibers with lenslets on both input and output side, such that both spatial and temporal coherence is maintained across the fiber bundle for possible wavefront/amplitude control through the fiber bundle.

S2.01 Cont'd

Wavefront Measurement and Control Technologies

- Small stroke, high precision, deformable mirrors and associated driving electronics scalable to 10,000 or more actuators (both to further the state-of-the-art towards flight-like hardware and to explore novel concepts). Multiple deformable mirror technologies in various phases of development and processes are encouraged to ultimately improve the state-of-the-art in deformable mirror technology. Process improvements are needed to improve repeatability, yield, and performance precision of current devices.
- Instruments to perform broad-band sensing of wavefronts and distinguish amplitude and phase in the wavefront.
- Integrated mirror/actuator programmable deformable mirror.
- Multiplexers with ultra-low power dissipation for electrical connection to deformable mirrors.
- Low-order wavefront sensors for measuring wavefront instabilities to enable real-time control and post-processing of aberrations.
- Thermally and mechanically insensitive optical benches and systems.

S2.01 Cont'd

Optical Coating and Measurement Technologies

- Instruments capable of measuring polarization cross-talk and birefringence to parts per million.
- Highly reflecting, uniform, broadband coatings for large (> 1 m diameter) optics.
- Polarization-insensitive coatings for large optics.
- Methods to measure the spectral reflectivity and polarization uniformity across large optics.
- Methods to apply carbon nanotube coatings on the surfaces of coronagraphs for broadband suppression of visible to NIR.

Other

- Methods to fabricate diffractive patterns on large optics to generate astrometric reference frames.
- Artificial star and planet point sources, with 1e10 dynamic range and uniform illumination of an f/25 optical system, working in the visible and near infrared.
- Deformable, calibrated, collimating source to simulate the telescope front end of a coronagraphic system undergoing thermal deformations.
- Technologies for high contrast integral field spectroscopy, in particular for microlens arrays with or without accompanying mask arrays, working in the visible and NIR (0.4 - 1.8 microns), with lenslet separations in the 0.1 -0.4 mm range, in formats of ~140x140 lenslets.

S2.02 Precision Deployable Optical Structures and Metrology

Lead Center: JPL, subtopic mgr Greg Agnes
Participating Center(s): GSFC, LaRC

- Proposed* future NASA Missions in astrophysics, such as the Wide-Field Infrared Survey Telescope (WFIRST), Large Ultraviolet Visible Infrared (LUVOIR) telescope, and Habitable Planet Explorer (HabEX), the Exo-C coronagraph, and Exo-S starshade will push the state of the art in current optomechanical technologies. (*Pre-decisional information, for discussion purposes only.)
- "Everything but the shiny stuff"
- Precision deployable structures and metrology for optical telescopes (e.g. innovative active or passive deployable primary or secondary support structures).
- Architectures, packaging and deployment designs for large sunshields and external occulters.
- Innovative concepts for packaging fully integrated subsystems (e.g. power distribution, sensing, and control components).
- Mechanical, inflatable, or other precision deployable technologies.
- Thermally stable materials (CTE < 1ppm) for deployable structures.
- Innovative testing and verification methodologies.
- Innovative systems that minimize complexity, mass, power, and cost.
- Proposals should show an understanding of one or more relevant science needs, and present a feasible plan to fully develop the relevant subsystem technologies and to transition into future NASA program(s).

Current Phase I Awards

2016 Program Phase I		Announced April 19, 2017
S2.01	Boston Micromachines Corp.	Technology Development for High-Actuator Count MEMS DM Systems
S2.01	Microscale, Inc.	Next-Generation Deformable Mirrors for Astronomical Coronagraphy by Utilizing PMN-PT Single Crystal Stack Actuators in Integration with Driver ASIC
S2.01	Nanohmics, Inc.	Proximity Glare Suppression for Astronomical Coronagraphy
S2.01	Photonic Cleaning Technologies, LLC	Polymer Coating-Based Contaminat Control/Elimination for Exo-S Starshade Probe
S2.01	Lambda Consulting/Advanced Nanophotonics (GSFC Monitor)	Proximity Glare Suppression Carbon Nanotubes
S2.02	Tendeg, LLC	Redundant Starshade Truss Deployment Motor/Cable Assembly
S2.04	ZeCoat Corp. (JPL monitor)	Battery-Powered Process for Coating Telescope Mirrors in Space

Current Phase II Awards

2016 Program Phase II		Announced March 8, 2017
S2.01	Tendeg LLC	Robust Optical Edge for a Starshade Petal
S2.02	Tendeg LLC	Solar Array for a Starshade Inner Disk
2015 Program Phase II		Announced March 16, 2016
S2.01	Boston Micromachines Corp.	Improved Yield, Performance, and Reliability of High-Actuator-Count Deformable Mirrors
S2.01	Sunlite Science & Technology, Inc.	Switching Electronics for Space-Based Telescopes with Advanced AO Systems
S2.02	Roccor, LLC	Dimensionally Stable Structural Space Cable